

Name: _____

Ray Optics PhET Lab

Introduction:

When you hold your glasses far away from your face, what do you see? If you look through a magnifying glass and move it away from your face, something odd happens as you look through the moving lens. The light that reflects off images and passes through a lens before it arrives at your eye can be simulated as a series of rays. In this lab, you will investigate lens optics using the 3-ray system (parallel-focal, focal-parallel, central). Remember, the *real* focal point of a lens is *behind* the lens. The lens we will use in this simulation is a thin double-convex lens.



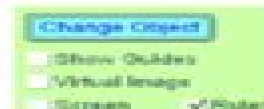
Geometric Optics

Important Formulas: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ or $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ $\frac{1}{f} = (n - 1) \frac{2}{R}$ $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$ or $m = \frac{h_i}{h_o} = \frac{-q}{p}$

Please note that in some texts, the object's distance is given by "p" and the image's by "q"

Procedure: PhET Simulations → Play With Sims → Light and Radiation → Geometric Optics Run Sim!

- Take some time and familiarize yourself with the simulation. You are able to move the object and the lens and change the characteristics of the lens. During this lab, be sure to always anchor your image on the principal axis. The pencil's eraser works well for this.
- Click Principal rays to draw the rays using the 3-ray system you learned in class.
- Move the object towards the lens. What happens to the image formed on the other side of the lens?



- As you move the object inside the lens' focal point something odd happens. Rays that don't meet **diverge**. Does this mean no image will be formed? _____ Where is the image? _____
- Click on "Virtual Image." How are a real image and a virtual image similar? _____ How are they different? _____
- Click on the ruler. You will need to make several measurements during the lab. You may, if you wish, leave your measurements in **cm** when using the formulas given above.
- Set the lens's refractive index (n) to 1.8 and the radius of curvature (R) to 0.7m. Use the appropriate equation above to solve for the focal distance (f). $f =$ _____



(Measure the focal distance to confirm your answer.)

- Using the focal distance you just found, complete the table below and check your work in the simulation.

focal distance (f)	distance object (d _o)	distance image (d _i)	magnification (m)
	120. cm		
	90. cm		
	60. cm		
	30. cm		
	15 cm		

Ray Optics Phet Lab

Yuri Shvyd'ko



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Technology and Innovation in Learning, Teaching and Education Arsénio Reis, João Barroso, Paulo Martins, Athanassios Jimoyiannis, Ray Yueh-Min Huang, Roberto Henriques, 2023-01-01 This book constitutes the proceedings of the Third International Conference on Technology and Innovation in Learning Teaching and Education TECH EDU 2022 was held in Lisbon Portugal in August September 2022 The 21 full papers and 18 short paper presented in this volume were carefully reviewed and selected from 80 submissions The papers are organized in the following topical sections Emergent technologies in education Online learning and blended learning Computer science education and STEM Digital tools and STEM learning ICT and critical thinking in higher education Digital transformation in higher education Artificial Intelligence in Education

100 Brain-Friendly Lessons for Unforgettable Teaching and Learning (9-12) Marcia L. Tate, 2019-07-24 Use research and brain based teaching to engage students and maximize learning Lessons should be memorable and engaging When they are student achievement increases behavior problems decrease and teaching and learning are fun In 100 Brain Friendly Lessons for Unforgettable Teaching and Learning 9 12 best selling author and renowned educator and consultant Marcia Tate takes her bestselling Worksheets Don t Grow Dendrites one step further by providing teachers with ready to use lesson plans that take advantage of the way that students really learn Readers will find 100 cross curricular sample lessons from each of the eight major content areas Earth Science Life Science Physical Science English Finance Algebra Geometry Social Studies Plans designed around the most frequently taught objectives found in national and international curricula Lessons educators can immediately replicate in their own classrooms or use to develop their own 20 brain compatible research based instructional strategies that work for all learners Five questions that high school teachers should ask and answer when planning brain compatible lessons and an in depth explanation of each of the questions Guidance on building relationships with students that enable them to learn at optimal levels It is a wonderful time to be a high school teacher This hands on resource will show you how to use what we know about educational neuroscience to transform your classroom into a place where success is accessible for all

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X-ray Optics and X-ray Microanalysis Stanford University. Biophysics Laboratory, 1963

Ray Optics R. K. Verma, 2006 This book Ray Optics cover the syllabus of ray optics for most of the universities in India The language of this book has been kept simple as could be consistent with precision and brevity detailed descriptions of experiments are not given It is sincerely hoped that fellow teachers will find this text book exciting and the student will find it interesting and useful Criticism and suggestions for further improvement shall be gratefully acknowledged Contents Light Fermat s Principle and its Applications Ray Optics Lenses Cardinal Points of an Optical System Thick Lenses Matrix Methods Dispersion Lens Aberrations Optical Instruments Speed of Light *An Introduction to X-Ray Physics, Optics, and Applications* Carolyn A. MacDonald, 2017-06-13 In this book Carolyn A MacDonald provides a comprehensive introduction to

the physics of a wide range of x ray applications optics and analysis tools Theory is applied to practical considerations of optics and applications ranging from astronomy to medical imaging and materials analysis Emphasizing common physical concepts that underpin diverse phenomena and applications of x ray physics the book opens with a look at nuclear medicine motivating further investigations into scattering detection and noise statistics The second section explores topics in x ray generation including characteristic emission x ray fluorescence analysis bremsstrahlung emission and synchrotron and laser sources The third section details the main forms of interaction including the physics of photoelectric absorption coherent and Compton scattering diffraction and refractive reflective and diffractive optics Applications in this section include x ray spectroscopy crystallography and dose and contrast in radiography A bibliography is included at the end of every chapter and solutions to chapter problems are provided in the appendix Based on a course for advanced undergraduates and graduate students in physics and related sciences and also intended for researchers An Introduction to X Ray Physics Optics and Applications offers a thorough survey of the physics of x ray generation and of interaction with materials Common aspects of diverse phenomena emphasized Theoretical development tied to practical applications Suitable for advanced undergraduate and graduate students in physics or related sciences as well as researchers Examples and problems include applications drawn from medicine astronomy and materials analysis Detailed solutions are provided for all examples and problems

X-ray Optics and Microanalysis ,1984 **X-Ray Optics** Yuri Shvyd'ko,2004-06-25 The generation of radiation with well defined frequency and wavelength and the ability to precisely determine these quantities are of fundamental importance in physics and other natural sciences Monochromatic radiation enables both very accurate structure determinations and studies of the dynamics of living and non living matter It is crucial for the realization of standards of time and length for the determination of fundamental constants and for many other aspects of basic research Bragg backscattering from perfect crystals is a tool for creating manipulating and analyzing x rays with highest spectral purity It has the unique feature of selecting x rays with narrow spectral bandwidth This book describes the theoretical foundations and principles of x ray crystal optics with high spectral resolution Various experimental studies and applications are presented and the author also addresses the development of instrumentation such as high resolution x ray monochromators analyzers wavelength meters resonators and interferometers The book will be a valuable source of information for all students and researchers working in the field of x ray optics

Linear Ray and Wave Optics in Phase Space Amalia Torre,2029-01-15 *Linear Ray and Wave Optics in Phase Space* Second Edition is a comprehensive introduction to Wigner optics The book connects ray and wave optics offering the optical phase space as the ambience and the Wigner function based technique as the mathematical machinery to accommodate between the two opposite extremes of light representation the localized ray of geometrical optics and the unlocalized wave function of wave optics Analogies with other branches of classical and quantum physics such as classical and quantum mechanics quantum optics signal theory and magnetic optics

are evidenced by pertinent comments and or rigorous mathematics Lie algebra and group methods are introduced and explained through the elementary optical systems within the ray and wave optics contexts the former being related to the symplectic group and the latter to the metaplectic group In a similar manner the Wigner function is introduced by following the original issue to individualize a phase space representation of quantum mechanics which is mirrored by the issue to individualize a local frequency spectrum within the signal theory context The basic analogy with the optics of charged particles inherently underlying the ray optics picture in phase space is also evidenced within the wave optics picture in the Wigner phase space This second edition contains 150 pages of new material on Wigner distribution functions ambiguity functions for partially coherent beams and phase space picture and fast optics All chapters are fully revised and updated All topics have been developed to a deeper level than in the previous edition and are now supported with Mathematica and Mathcad codes Provides powerful tools to solve problems in quantum mechanics quantum optics and signal theory Includes numerous examples supporting a gradual and comprehensive introduction to Wigner optics Treats both ray and wave optics resorting to Lie algebra based methods Connects the subject with other fields such as quantum optics quantum mechanics signal theory and optics of charged particles Introduces abstract concepts through concrete examples Includes logical diagrams to introduce mathematics in an intuitive way Contains 150 pages of new material on Wigner distribution functions ambiguity functions for partially coherent beams and phase space picture and fast optics Supported with Mathematica and Mathcad codes

Coherent X-Ray Optics David Paganin, 2006-01-12 This book gives a thorough treatment of the rapidly expanding field of coherent x ray optics which has recently experienced something of a renaissance with the availability of third generation synchrotron sources It is the first book of its kind The author begins with a treatment of the fundamentals of x ray diffraction for both coherent and partially coherent radiation together with the interactions of x rays with matter X ray sources optics elements and detectors are then discussed with an emphasis on their role in coherent x ray optics Various facets of coherent x ray imaging are then discussed including holography interferometry self imaging phase contrast and phase retrieval Lastly the foundations of the new field of singular x ray optics are examined Most topics are developed from first principles with numerous references given to the contemporary research literature This book will be useful to x ray physicists and students together with optical physicists and engineers who wish to learn more about the fascinating subject of coherent x ray optics

An Introduction to X-ray Physics, Optics, and Applications Carolyn Ann MacDonald, 2017 In this book Carolyn A MacDonald provides a comprehensive introduction to the physics of a wide range of x ray applications optics and analysis tools Theory is applied to practical considerations of optics and applications ranging from astronomy to medical imaging and materials analysis Emphasizing common physical concepts that underpin diverse phenomena and applications of x ray physics the book opens with a look at nuclear medicine motivating further investigations into scattering detection and noise statistics The second section explores topics in x ray generation including characteristic emission x ray

fluorescence analysis bremsstrahlung emission and synchrotron and laser sources The third section details the main forms of interaction including the physics of photoelectric absorption coherent and Compton scattering diffraction and refractive reflective and diffractive optics Applications in this section include x ray spectroscopy crystallography and dose and contrast in radiography A bibliography is included at the end of every chapter and solutions to chapter problems are provided in the appendix Based on a course for advanced undergraduates and graduate students in physics and related sciences and also intended for researchers An Introduction to X Ray Physics Optics and Applications offers a thorough survey of the physics of x ray generation and of interaction with materials Common aspects of diverse phenomena emphasized Theoretical development tied to practical applications Suitable for advanced undergraduate and graduate students in physics or related sciences as well as researchers Examples and problems include applications drawn from medicine astronomy and materials analysis Detailed solutions are provided for all examples and problems

X-Ray Optics and Microanalysis Melissa A. Denecke, Clive T. Walker, 2010-05-12 ICXOM Series is a platform dedicated for reporting progress in fundamental and applied research in x ray optics and micro and nano analysis by means of x ray beams with an ICXOM20 emphasis on synchrotron sources electrons or other energetic particles including application examples as well as methodological and instrumental developments

Light and Optics Abdul Al-Azzawi, 2018-10-03 Since the invention of the laser our fascination with the photon has led to one of the most dynamic and rapidly growing fields of technology As the reality of all optical systems quickly comes into focus it is more important than ever to have a thorough understanding of light and the optical components used to control it Comprising chapters drawn from the author's highly anticipated book Photonics Principles and Practices *Light and Optics Principles and Practices* offers a detailed and focused treatment for anyone in need of authoritative information on this critical area underlying photonics Using a consistent approach the author leads you step by step through each topic Each skillfully crafted chapter first explores the theoretical concepts of each topic and then demonstrates how these principles apply to real world applications by guiding you through experimental cases illuminated with numerous illustrations The book works systematically through light light and shadow thermal radiation light production light intensity light and color the laws of light plane mirrors spherical mirrors lenses prisms beamsplitters light passing through optical components optical instruments for viewing applications polarization of light optical materials and laboratory safety Containing several topics presented for the first time in book form *Light and Optics Principles and Practices* is simply the most modern comprehensive and hands on text in the field

Ray Optics on Surfaces Mostafa Ghandehari, University of Texas at Arlington. Department of Mathematics, 1997*

X-ray Optics and Microanalysis, 2012 *Introductory to Ray Optics* Arpit Saxena, 2010

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